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ABSTRACT

This paper describes a method for teaching introductory biology using a multimedia approach. This methodology aimed to increase student participation, promote independent learning, and enhance computer literacy. Five multimedia tools were used to teach the course. PowerPoint slide shows were used to present lecture material; videodiscs displayed images and animations in electronic slide shows; and CD-ROMs that accompanied the textbook included interactive animations, still images, quizzes, and test banks. All students were required to obtain an e-mail account for correspondence. A survey in which students responded to several questions evaluating the course is also included. (SAH)

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THE ELECTRONIC BIOLOGY CLASSROOM: IMPLEMENTATION AND STUDENT OPINION

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INTRODUCTION

I began to question my approach to teaching in April, 1995 when a student who had to miss class asked if I was "just going to lecture" that day. When I shared her question with a senior biology faculty member, he replied that he had heard that comment many times during his career. Perhaps this question is heard more often by science faculty, but I suspect that it has been heard by numerous professors in other disciplines. The question ultimately prompted me to revise my approach to teaching introductory biology. Although I have discussed these changes previously (Davis 1997), I will provide an overview of my initial classroom transformation, along with additional changes since the initial revision. I will then present the results of a survey instrument that queries students about their opinion of the "Electronic Biology Classroom," their perception of how the new instructional technologies have impacted their learning, and their desire for the incorporation of technology in other classes. Finally, I discuss the advantages and disadvantages of using multimedia in the classroom.

OPPORTUNITY FOR CHANGE

For the past three years, the Office of Information and Instructional Technology (OIIT) for the University System of Georgia has sponsored Connecting Teachers and Technology, a faculty development workshop that acquaints participants with emerging instructional technologies and provides them with a variety of resources.Selected to participate in the workshop in the summer of 1995, I received an opportunity to change my teaching methods, along with resources to accomplish that change. OIIT charged participants to return to their home institutions and infuse some of the instructional technologies into an existing course so that the course would be "incomplete" without the technology. I left the workshop enamored with computer-assisted instruction and excited about the prospect of initiating a change in pedagogy and improving instruction.

BIOLOGY 112

I chose to incorporate the technology into my Biology 112 class. Biology 112 is the second course in an introductory biology sequence for non-science students here at North Georgia College & State University (NGCSU). Biology 112 students have usually completed the first course in the sequence (Biology 111) and, like non-majors at other institutions across the country, arrive with varying levels of zeal. Students take Biol. 112 to satisfy the core curriculum requirement. Their interest in science is low and their anxiety about science is high. Many students have informed me that Biol. 112 is simply a hurdle they must cross and they are often content to "just make a C." Most are traditional age freshmen and sophomores that represent the videogame generation, accustomed to visual stimulation. Depending on their background, the computer skills of Biol. 112 students range from very good to non-existent. Because NGCSU is a small institution (~3200 students), Biol. 112 classes are usually small. I have taught Biol. 112 five times since initiating a change in pedagogy, and the class size has ranged from 22 - 34 students.

By introducing instructional technology into Biol. 112, my goal was to create a different learning environment. Using multimedia, I wanted to enliven classroom presentations and foster visual learning. I also wanted to increase student participation, promote independent learning and enhance computer literacy.

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THE INITIAL TRANSFORMATION

I transformed Biol. 112 from a traditional setting of chalk dust and erasers to a multimedia setting. My initial revision included six changes that created a different learning environment, one that has been termed by Henshaw (1997) as a "new chalk" approach.

1. PowerPoint Slide Shows

Each lecture became an electronic PowerPoint slide show that I created and presented with a computer. To illustrate concepts and enrich on-screen text, each slide show included numerous images from CD-ROMs and the World Wide Web. I used a Macintosh 540c laptop or a Compac DeskPro PC, along with an In-Focus 580 or Eiki 7000LC RGB projector to project on-screen images and text.

2. Videodiscs

In each class period I also interfaced videodisc images and animations with electronic slide shows. Because the RGB projectors had separate s-video and computer input connections, I could rapidly switch from figures, images and animations on videodisc to computer text and images using a remote control.

3. CD-ROM

I often used the CD-ROM that accompanies Biology: Concepts and Connections (Campbell et al. 1997) during class meetings. The CD-ROM has numerous features, including interactive animations, still images, quizzes and test banks. All resources on the CD-ROM correspond with appropriate chapters in the textbook. Concepts illustrated with the CD-ROM are also cross-referenced with corresponding modules in the text.

4. Computer-based Tutorials

Staff members in NGCSUís Department of Information Technology installed BC Tutor on desktop computers in two computer labs. BC Tutor is a software tutorial available free to faculty who adopt Biology: Concepts and Connections. All questions on BC Tutor are multiple choice. When a student answers a question, the tutorial explains why the answer is correct or incorrect. All questions are cross-referenced with specific modules in the textbook, and tutorial questions are different than those in the CD-ROM and those provided at the end of each textbook chapter.

5. E-Mail

I required all students to obtain an E-Mail account. In spring quarter 1996, less than half of the students had accounts on the first day of class. With the ongoing "computerization" (*sensu* Flora and Logan 1966) at NGCSU in the past two years, the requirement to obtain an account is almost unnecessary. This past quarter, all students had accounts on the first day of class.

Each quarter I created mail lists that allowed me to simultaneously send mail to all students. E-Mail provided a convenient means to post data from team-conducted lab experiments, remind students about revisions in upcoming laboratory procedures, post assignments for the World Wide Web, and pose thought questions before examinations. I also encouraged students to use E-Mail as an electronic forum to submit questions about lecture or lab concepts. Often, students submitted questions that were unrelated to syllabus topics but were relevant to biology. I posted all questions and their answers to the mail list and kept the identity of the questioners confidential.

E-Mail also provided the means to post expanded outlines of each lecture topic before introducing the topic in class. My goal was to create a class with less emphasis on note-taking and more emphasis on class discussion. Text from each electronic PowerPoint slide show could be copied from "outline view," then pasted directly into an E-mail message. Because students often wished to extract files from E-Mail and edit these outlines with a word processor, I held training sessions outside class and demonstrated this procedure. Students that

edited lecture outlines with a word processor (versus hand-editing copies of the outline printed from E-Mail) became more proficient using computers. Although I later abandoned the procedure of providing "notes" via E-Mail in favor of another approach (see Recent Changes section), it was very popular with students.

6. World Wide Web

I made numerous assignments on the Web to foster independent learning. Students used the Web to read about issues related to topics in class, including diverse subjects such as antibodies, Olestra, RU 486, and smoking. Students also used the Web to view images (such as tissue images archived in medical school image banks) and animations (such as heart movies and virtual cells) related to syllabus topics. I posted relevant URLs to the mail list and required students to visit these sites before scheduled tests. To ensure that students read Web materials, information on the Web sites was "fair game" on examinations. Students also accessed Web pages maintained by their textbook publisher to view online tutorials associated with chapters in the text. Occasionally, students accessed tutorials linked to home pages of other publishers

RECENT CHANGES

This past summer, I placed most course materials for Biol. 112 on the Web (http://www.ngc.peachnet.edu/academic/sciences/biology/davis/112home.htm). Students now learn how to access the Biol. 112 homepage on the first day of class. The course syllabus, general course policies, lab schedule and textbook information are all linked to this page. There are links with online quizzes and "process of science activities" maintained by the textbook publisher. Instead of receiving expanded outlines of lecture topics via E-Mail, students now access outlines for each syllabus topic via links in the homepage. The homepage provides access to instructions for BC Tutor and establishes links with GALILEO (the state of Georgia electronic library), web search engines and other relevant sites.

STUDENT OPINION

The response of students to my new approach in Biol. 112 has been extremely positive. After using the technology approach for two quarters, my course evaluations were very favorable. Comments were usually directed specifically at the "improvement" in Biol. 112 pedagogy compared to Biol. 111, regardless of the previous instructor. Because I wanted something other than anecdotal comments, I enlisted the help of a fellow colleague in developing a survey instrument that would permit me to quantify student attitudes about the course. Gleaning ideas from published surveys (Fox 1996, Flora and Logan 1996, Pridemore and Klein 1995, Avila et al. 1995), I created an instrument that queries students about their perception of the multimedia approach to teaching. Students complete the survey during the last week of class and receive two bonus points on the final exam as an incentive to return the completed form.

I have now administered the survey three times. Here is an overview of the number of students that have responded to the survey:

Term	Class Size	Number Responding
Winter 1997	24	21
Summer 1997	23	22
Winter 1998	34	34

The survey instrument consisted of 17 questions for the Winter 97 and Summer 97 groups. For the Winter 98 group, I added 5 additional entries (indicated below with an asterisk) for a total of 22 questions. The introduction for the survey follows, along with the survey questions and the studentsí responses. For each question, I have included the percentage of studentsí responses in parentheses next to each answer choice.

Survey Introduction: This survey is part of an evaluation study that faculty will use to make decisions about the learning environment in future classes. Your responses to the following statements and questions will assist faculty in making informed decisions about implementing change. To ensure that your responses are anonymous, please do not write your name on the document. For each statement or question, circle the letter that represents the most appropriate response.

Survey Questions and Responses:

1. I enjoyed the multimedia approach (computer-assisted lectures that present text, videodisc images and animations) used in this class.
a. strongly agree (76%)
b. agree (17%)
c. neutral (7%)
d. disagree (0%)
e. strongly disagree (0%)

2. I would recommend using multimedia in future Biology 112 classes.
a. strongly agree (78%)
b. agree (16%)
c. neutral (6%)
d. disagree (0%)
e. strongly disagree (0%)

3. I would recommend using multimedia in future Biology 111 classes.
a. strongly agree (73%)
b. agree (18%)
c. neutral (8%)
d. disagree (1%)
e. strongly disagree (0%)

4. I would recommend that faculty use multimedia in my other classes.
a. strongly agree ((56%)
b. agree (35%)
c. neutral (8%)
d. disagree (1%)
e. strongly disagree (0%)

*5. I would prefer a multimedia class more than a traditional "chalk and blackboard" class.
a. strongly agree (59%)
b. agree (20%)
c. neutral (15%)
d. disagree (3%)
e. strongly disagree (3%)

6. I found it helpful using the World Wide Web to receive lecture notes/outlines on a topic before the topic was discussed in class.
a. strongly agree (68%)
b. agree (25%)
c. neutral (6%)
d. disagree (1%)
e. strongly disagree (0%)

7. E-Mail was an effective way to receive "team data" obtained from the laboratory experiments.
a. strongly agree (49%)

b. agree (35%)
c. neutral (8%)
d. disagree (6%)
e. strongly disagree (1%)

8. It was helpful using E-Mail to read questions that other students submitted to the professor, and the professor's answers to them, when the questions were related to course topics.
a. strongly agree (44%)
b. agree (40%)
c. neutral (13%)
d. disagree (3%)
e. strongly disagree (0%)

9. I enjoyed using the computer-based tutorials (BC Tutor, CD-ROM questions/quizzes, World Wide Web quizzes).
a. strongly agree (43%)
b. agree (29%)
c. neutral (6%)
d. disagree (6%)
e. strongly disagree (0%)
f. I did not use the computer-based tutorials (16%)

10. Rate the degree to which the visual materials (computer presentations, videodisc images, WWW visuals) helped you gain a better understanding of the course material.
a. very good (58%)
b. good (35%)
c. average (6%)
d. poor (0%)
e. very poor (0%)

11. How much did the various tutorials (BC Tutor, CD-ROM questions/quizzes, World Wide Web quizzes) help your learning in the class?
a. helped a lot (35%)
b. helped some (49%)
c. had no effect (5%)
d. were detrimental to my learning (0%)
e. I did not use any of the tutorials (10%)

12. How did BC Tutor, the CD-ROM questions/quizzes, and the World Wide Web quizzes affect your grades?
a. helped a lot (33%)
b. helped some (49%)
c. had no effect (11%)
d. hurt my scores (0%)
e. I did not use BC Tutor, the CD-ROM or WWW quizzes (8%)

*13. I found it helpful to have access to Biol. 112 course materials on the World Wide Web.
a. strongly agree (44%)
b. agree (35%)
c. neutral (18%)
d. disagree (3%)
e. strongly disagree (0%)

*14. I recommend that faculty place course materials for Biology on the World Wide Web.
a. strongly agree (53%)
b. agree (38%)

c. neutral (9%)
d. disagree (0%)
e. strongly disagree (0%)

*15. I recommend that faculty in other departments place course materials for their courses on the World Wide Web.
a. strongly agree (47%)
b. agree (38%)
c. neutral (12%)
d. disagree (3%)
e. strongly disagree (0%)

*16. To what extent did access to course materials on the World Wide Web help your learning in the class?
a. helped a lot (41%)
b. helped some (50%)
c. had no effect (6%)
d. were detrimental to my learning (0%)
e. I did not use course materials on the Web (3%)

17. I consider my computer skills to be
a. more advanced than necessary (9%)
b. adequate for my needs (83%)
c. inadequate for my needs (8%)
d. non-existent (0%)

18. How much did this class increase your familiarity or comfort using computers?
a. significant increase (32%)
b. moderate increase (45%)
c. had no effect (22%)
d. reduced my familiarity/comfort (0%)

19. How important do you consider your computer skills to be in terms of your current needs as a student?
a. essential (48%)
b. important (49%)
c. of limited use (3%)
d. not very useful (0%)
e. irrelevant (0%)

20. How important do you consider your computer skills to be in terms of your future needs as a student?
a. essential (65%)
b. important (34%)
c. of limited use (1%)
d. not very useful (0%)
e. irrelevant (0%)

21. How important do you consider your computer skills to be in terms of your future needs as a college graduate in the work force?
a. essential (75%)
b. important (23%)
c. of limited use (1%)
d. not very useful (0%)
e. irrelevant (0%)

22. To what extent do you feel hopeful or skeptical about the opportunity to develop computer skills during the course of your undergraduate education?
a. sure you will have the opportunity (48%)
b. hopeful you will have the opportunity (44%)
c. skeptical that you will have the opportunity (8%)
d. sure that you will not have the opportunity (0%)

The results of this survey indicate strong support for using multimedia in the classroom. Ninety-four percent of responding students recommended using multimedia in future Biol. 112 classes and ninety-one percent recommended using this approach in Biol. 111. Ninety-one percent of responding students recommended that faculty in other disciplines use multimedia in their courses. Ninety-three percent of responding students found it helpful to access outlines on a lecture topic before I discussed the topic in class. Ninety-three percent also indicated that the visual materials associated with multimedia helped them better understand course materials. Eighty-four percent indicated that the computer-based tutorials helped their learning. Seventy-nine percent of the Winter 98 group preferred a multimedia class to a traditional "chalk and blackboard" class.

Responses to questions related to E-Mail also indicate its value as a teaching tool. Eighty four percent agreed that E-Mail was an effective way to receive class data from lab experiments and eighty four percent found it helpful to use E-Mail as an electronic forum.

Responses by the Winter 98 group to questions pertaining to the World Wide Web suggest that the Web is a teaching resource that faculty should explore further. Ninety-one percent of respondents in the Winter 98 term indicated that access to material on the Web helped their learning. Seventy-nine percent of these students found it helpful to access Biol. 112 course materials on the Web and eighty five percent recommended that faculty in other departments place their course materials on the Web. Student attitudes about the Web lend support to Kieleyís (1996) contention that the Web provides a model for future direction of multimedia.

From an instructor's perspective, the apparent popularity of instructional technology is encouraging. Perhaps just as encouraging, the campus culture at NGCSU is such that 92% of the students are optimistic about receiving the opportunity to develop computer skills during the course of their undergraduate education. That optimism seems justified, as 99% of the students that I surveyed consider their computer skills to be essential or important in their future needs as a student. Ninety-eight percent consider these skills to be essential or important as college graduates in the work force.

Two obvious questions:

DISADVANTAGES OF MULTIMEDIA

Perhaps the most distinct disadvantage with multimedia is the time and labor commitment it requires (see comments by Goolkasian 1996, Gotsick and Gotsick 1996, Kieley 1996, Solomon 1994). Sammons (1994) reported that professors spend 20 hours each week (150-200 hours for one course) developing multimedia presentations. Stoloff (1995) noted that he used semester leave to develop materials for a 3-credit psychology class. After attending the OIIT workshop, I received one-third release time for one quarter to develop instructional materials. Obviously, learning to use any presentation software requires a time investment. In my experience, however, obtaining images that illustrate examples or class concepts requires more time than learning to use software. Certainly, it is much simpler to walk into a classroom with lecture notes and chalk than create slide shows with a computer. Moreover, it is usually necessary to set up electronic equipment and preview presentations before each class. The collective time investment is a serious concern for many faculty because tenure and promotion committees usually favor scholarship in the research arena over scholarship associated with teaching (see comments by Solomon 1994). Efforts to improve teaching and enhance learning are often valued less by administrations than efforts aimed at producing refereed publications. Incentives must be provided to convince faculty that time spent developing instructional materials is not better spent pursuing research.

Another disadvantage of multimedia is the cost of the equipment and accessing it. Minimal equipment

includes a laserdisk player, computers with CD-ROM drive, and a projection system (RGB projector or LCD panel with overhead projector). All are expensive. These items must be dedicated to a particular classroom or mounted on a cart that can be moved from one classroom to another. Whether dedicated to one classroom or stationed on a movable cart, equipment security is always an issue. Because multimedia equipment is expensive, and thus limited in quantity, access to the "technology classroom" or the "technology cart" can pose problems for faculty who wish to use items at the same time.

The projection system also requires a dimmed room to produce acceptable on-screen images, despite recent improvements in projector quality. Because most classrooms have switched-on/off lighting without a dimming feature, projected image quality often suffers. In classrooms with a dimmed lighting feature, low light levels that increase image quality also also decrease student attentiveness. Students get sleepy in a dimmed room.

ADVANTAGES OF MULTIMEDIA

Even though the disadvantages warrant concern, they are outweighed by advantages. Multimedia improves communication with students. The electronic classroom creates more opportunity for independent student learning. Eighty-four percent of the students surveyed indicated that the independent learning assignments helped their learning. In Biol. 112, computer-assisted presentations enliven the classroom environment and promotes visual learning. Images and animations significantly increase student understanding of certain concepts. Ninety-three percent of the students responding to the survey reported that the visual materials used in class increased their understanding of course topics. Results from the survey reveal that students not only enjoy this different approach to teaching, they prefer the multimedia classroom to a traditional one. Students find instructional technology helpful, effective and enjoyable. In my experience, students show an increased desire to learn. Students also become more proficient using computers because they are taking a biology class.

Two obvious questions remain. Do students do better on exams since the change? Do they learn more with this approach? I can offer only qualitative answers to these questions. Since I moved to multimedia, Biol. 112 has also evolved in other ways. Syllabus topics are different than in the past. To enhance relevance of class topics, I have omitted all lecture sections on plant biology and increased coverage on immunity and reproduction. I have also changed my testing methods. Test questions have more emphasis on application of course concepts and less emphasis on "memorization" of discipline-specific content. Grade distributions for Biol. 112 are about the same as before, but students probably work harder for those grades. Subjectively, they seem to learn more now than in the past.

Several faculty have reported to me their personal satisfaction and renewed excitement for teaching after shifting to multimedia. I have experienced similar rejuvenation. Using multimedia to supplement teaching and meet instructional goals offers a fresh perspective. More importantly, students recommend this approach to teaching. Although not a panacea for all educational ills, the potential of technological advances for implementing instructional improvement is evident. It is an exciting time in higher education.

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